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*Indian Standard*

# METHOD FOR DETERMINATION OF BRITTLENESS OF PHOTOGRAPHIC FILM

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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# *Indian Standard*

# METHOD FOR DETERMINATION OF BRITTLENESS OF PHOTOGRAPHIC FILM

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# *Indian Standard*

# METHOD FOR DETERMINATION OF BRITTLENESS OF PHOTOGRAPHIC FILM

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 27 December 1982, after the draft finalized by the Photographic Materials Sectional Committee had been approved by the Chemical Division Council.

**0.2** Brittleness is a property of many materials under specific atmospheric condition, which cause them to break or crack when deformed by bending. In case of photographic films it is an undesirable property. For satisfactory performance of films in equipment require sufficient flexibility or lack of brittleness to ensure good tolerances to bending stresses under the atmospheric conditions likely to be encountered in practice.

**0.3** Photographic film is essentially a laminate of two or more different materials, generally a plastic support and the sensitive emulsion. The latter is usually made of gelatin or other polymeric binder for the image-forming chemicals.

**0.4** Different types of brittle failure occur when film is subjected to stress in different ways. Failure may consist of very fine cracks in the emulsion ( without a break in the support ) which are objectionable when the photograph is viewed. Failure may also consist of cracks in the support or a complete break.

**0.5** Brittleness is not an absolute physical property. The apparent brittleness of photographic film is very dependent upon the manner in which the film is mechanically treated as well as the ambient conditions of temperature and relative humidity. No single brittleness test is capable of ranking a variety of types of film as they would behave under widely different practical conditions. The wedge brittleness test specified in this standard subjects film to a high rate of strain in a simple folding action. It has been an accepted method of rating film brittleness for many years and has correlated with many practical applications. Other methods used consist of flex tests in which the film is subjected to a repeated folding action until it breaks. There are considerable number of flexibility tests available but standardization is not possible.

**0.6** Brittleness of photographic film is affected adversely by both reduced temperature and reduced relative humidity. Film brittleness at low relative humidity is encountered more frequently than film brittleness at low temperature in most applications. Moreover, a marked change in film brittleness may occur with only a very small change in relative humidity below a level of about 25 percent. This means that brittleness tests on photographic film should be carried out only in an atmosphere which is very accurately controlled with respect to both temperature and relative humidity.

**0.7** Film brittleness is very dependent on the sample thickness, increasing with increase in thickness of either base or emulsion. For this reason, the thickness of the film layers must be considered when comparing the behaviour of different films. The thermal and moisture history of the film between manufacture and testing may also affect the brittleness, even though the sample is reconditioned to a standard temperature and humidity. Gelatin is generally more brittle than film base, so that photographic film having a gelatin layer on only one side is usually more brittle if bent with the gelatin side out ( that is, gelatin under tension ). Brittleness of photographic film may vary with the bend axis depending upon the orientation of the base. There is generally no directional effect in the brittleness of the emulsion.

**0.8** This standard is based on ISO 6077-1980 Photography — Determination of brittleness of photographic film — Wedge brittleness test, issued by the International Organization for Standardization.

**0.9** In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

## 1. SCOPE

**1.1** This standard prescribes the method for determining quantitatively the brittleness of photographic film.

**1.1.1** This test is not a universal brittleness test for all films in all possible applications. In a particular situation the test may not correctly rate films for brittleness, and some special test may have to be devised to duplicate the particular type of stress encountered.

**1.1.2** The method is applicable to film with or without a gelatin backing, and may also be applied to either raw or processed film, although the brittleness level of a given film may be quite different after processing from that before processing.

*Rules for rounding off numerical values ( *revised* ).

## 2. TEST SAMPLES

**2.1 Preparation** — Film samples shall be cut in an atmosphere of 20° to 23°C and 40 to 55 percent relative humidity. The sample cutter shall be of a precision type and shall be kept sharp so that the sample edges are smooth and free of nicks. Rubber gloves shall be worn by the operator in handling the samples, both in their preparation and testing.

NOTE — If the samples are cut at relative humidities lower than 40 percent, it may be difficult to obtain smooth edges. Handling under these conditions may also cause emulsion cracking which will effect the subsequent brittleness results. Exposure to relative humidities greater than 55 percent may permanently alter the subsequent brittleness behaviour of some films.

**2.2 Selection** — A set of ten samples shall be prepared for each test, if film size permits, one set of samples shall be cut in the machine direction and a second set in the transverse ( cross ) direction. If the film has a discrete backing layer, a separate set of samples shall be cut in at least one of the two principal directions for testing with the backing convex.

**2.3 Size** — The standard film samples shall be 350 mm long by 15 to 16 mm wide. Although not recommended, 16 mm perforated film may be tested for comparative purposes only, by cutting off the perforated edges and testing a sample 9 mm wide. Similarly, 35 mm film may be tested, but the results are not necessarily comparable to the standard 15 to 16 mm width.

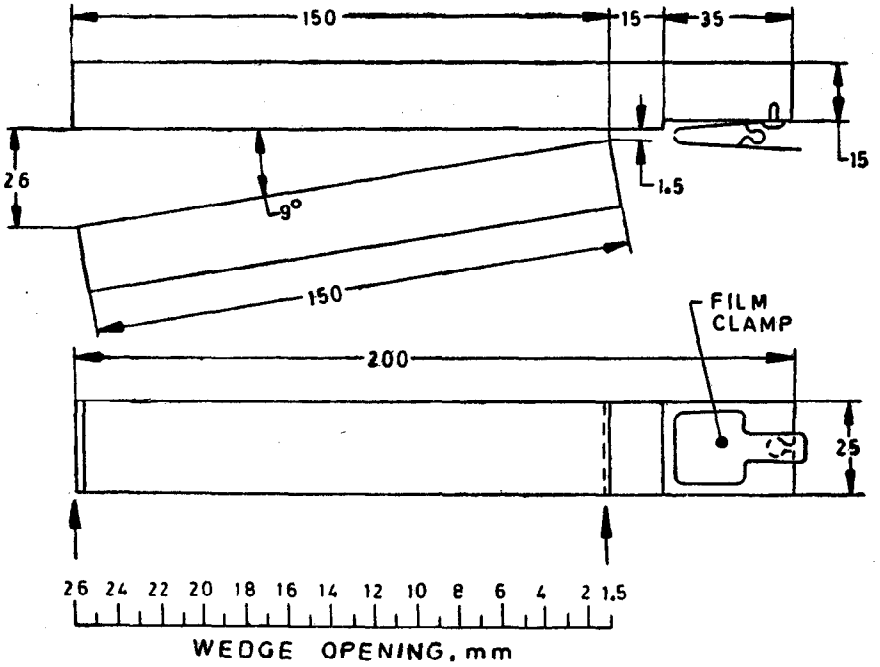
## 3. PRINCIPLE OF THE METHOD

**3.1** The method is based on the measurement of the diameter of curvature at which a film loop fails when subjected to a high rate of strain.

## 4. APPARATUS

**4.1 Wedge Brittleness Apparatus** — The wedge brittleness apparatus consists of two non-parallel metal plates or jaws, which form wedge or *V* at an angle of 9·0°, and have the dimensions shown in Fig. 1. A clamp is attached to one jaw at the narrow end of the wedge to hold one end of the film sample. A scale is provided which gives the wedge separation between the two jaws at any point.

NOTE — The dimensions given in the figure are recommended for photographic film having wedge brittleness values of up to 25 mm. This is generally satisfactory for most films. If more brittle film is to be tested, a wedge with a wider opening shall be used. This may be accomplished by increasing the openings at both the narrow and wide ends of the wedge, but maintaining the angle between them at 9°. The scale shall be adjusted accordingly.




All dimensions in millimetres.

FIG. 1 WEDGE BRITTLENESS TESTER

NOTE — The distance between the clamp and the narrow opening of the wedge is not critical and may be between 3 and 15 mm. To accommodate 35 mm width samples, the wedge height may be increased from 25 to 45 mm.

**4.2 Test Chamber** — An air-conditioned cabinet or walk-in room shall be used for both conditioning and testing. The temperature shall be controlled to within ± 1°C, and the relative humidity to within ± 1 percent of the specified values The linear air velocity shall be at least 15 cm/s. If a walk-in conditioned room is used, the air velocity shall be adequate to maintain the conditions specified. The number of personnel permitted in the room during testing shall be limited and precautions shall be taken to prevent the operator's breath reaching the film.

## 5. CONDITIONING AND TEST CONDITIONS

**5.1 Conditioning of Specimens** — Samples shall be conditioned in the test chamber until practicable moisture equilibrium has been reached. This may be determined by weighing samples at regular intervals and determining, the time at which further conditioning does not appreciably change the mass. In many instances this time will be in the vicinity of 4 hours but actual times will vary due to access of the conditioning air

and the type and thickness of the material. The conditioning time shall not exceed 24 hours. The film shall be held in racks permitting free circulation of air around the samples.

**5.2 Testing Conditions** — The standard relative humidity for testing shall be 15 ± 1 percent. However, other relative humidities such as 10, 20 and 35 percent or approximations thereof, utilizing stable saturated solutions in small enclosures may prove useful. The standard temperature for testing shall be 23 ± 1°C. However, other temperatures may be used where the effect of temperature is to be investigated.

**5.2.1** The film test samples shall not be removed from the conditioning atmosphere for testing except at a temperature of 0°C. For testing film at 0°C or below, the test samples shall be conditioned at the desired relative humidity at 23°C, sealed in small taped cans, cooled long enough to reach the test temperature, and then removed, one at a time, for testing.

NOTE — Direct control of relative humidity at temperatures of 0°C or below is impracticable, but once film is conditioned, the rate of gain or loss of moisture is much lower at low temperatures.

## 6. PROCEDURE

**6.1** Fasten one end of the film test sample in the clamp at the narrow end of the wedge. Loop the test sample, emulsion-out, within the wedge, with a sufficient length at the free end, extending through the narrow opening of the wedge, to allow it to be pulled. Make a mark on the clamped end of the sample at the point where the narrow end of the wedge starts ( 1·5 mm scale marking ). Pull the film sample by the free end completely through the narrow opening of the wedge using a smooth, rapid motion completed within 1 s. Remove the sample from the clamp and lay it on the scale with the mark aligned at the end corresponding to 1·5 mm. Read the wedge separation point of failure of the test sample directly from the scale to the nearest 0·5 mm.

**6.2** If emulsion cracks occur, record the wedge separation for both the first emulsion and the complete film break. The former can also be found from the broken sample, it being necessary to examine both halves of the film.

NOTE — Emulsion cracks can best be seen under strong illumination by a directed ( parallel, collimated ) light beam. Frequently, examination of emulsion cracks can most easily be detected from the back of the film, provided it does not have a backing layer. Holding the sample under a slight tension or viewing with transmitted light is sometimes helpful.

**6.3** Films which have emulsion on both sides or have a discrete backing layer shall be tested in duplicate, one set with the emulsion convex and one set with the backing convex.

**6.4** Films shall have satisfactory adhesion between the emulsion and support for the wedge separation to reflect the film brittleness. If the adhesion is not satisfactory, the emulsion will strip from the support during the test and the wedge separation at stripping will be dependent upon the emulsion-base adhesion and will not reflect film brittleness.

## 7. TEST REPORT

**7.1 Test Data** — Test samples which pass through the narrowest part of the wedge ( 1·5 mm ) without failure shall be arbitrarily assigned a value of 1 mm to permit averaging with those test samples which fail by breaking.

**7.1.1** The following values shall be reported for each manner in which the film was tested, for example lengthwise, widthwise, emulsion convex, and backing convex:

a) Average wedge separation for the first emulsion crack for those samples which exhibit cracks;

b) Percentage of samples showing emulsion cracks;

c) Average wedge separation for complete film breaks ( including values of 1 mm for those samples which did not break );

d) Percentage of samples showing complete film breaks;

e) Average wedge separation for first failure, whether a crack or break ( including values of 1 mm for those samples which did not fail );

f) Temperature and relative humidity of the test; and

g) Average thickness of the sample ( and width, if not 15 to 16 mm ).

**7.2 Significance** — It is important to note whether the film fails by emulsion cracks or by a complete break, since this can give information about the reasons for brittleness. Emulsion cracks are influenced by the brittleness of the emulsion layer and the emulsion base adhesion. Film breaks are affected by these two factors together with the brittleness of the film base. First failure measurements give a single value for the brittleness of the film laminate, but no information as to cause of the brittleness.

**7.2.1** For films of thickness approximately 0·15 mm, an average first failure value of 3 mm or less indicates a flexible film at the conditions under which the test was made. A value of 10 mm or greater denotes a brittle film. These ranges differ for films which are either thicker or thinner. A difference in the average wedge brittleness between two films of less than 1 mm is not considered to be significant.